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DTX-145 Test Results

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MANUFACTURER: RITRON, INC.
505 West Carmel Drive
Carmel, IN 46032

MODEL: DTX-145

TYPE OF UNIT: VHF-FM Two Way Radio Transceiver Module

FCC ID: AIERIT17-145

DATE: 11 May 2010

The following is a list of attached exhibits required by the Federal Communications Commission for the application to and grant of FCC Type Acceptance.

List of Test Equipment Used	2.947 (d)	pg 2
Description of Measurement Facility	2.947 (d)	pg 3 + 4
Radio Frequency Power Output	2.1046	pg 5 + 6
Transmitter Audio Overall Response	2.1047 (a)	pg 7
Transmitter Low-Pass Filter Response	2.1047 (a)	pg 8
Modulation Limiting	2.1047 (b)	pg 9 + 10
Emissions Designator	2.1049 (c)	pg 11
Occupied Bandwidth	2.1049 (c)(1) 90.210(d)	pg 12-15
Spurious Emissions at Antenna Terminals - Transmitter	2.1051	pg 16
Field Strength of Spurious Emissions	2.1053 (b)	pg 17 + 18
Frequency Stability vs. Temperature	2.1055 (a)	pg 19
Frequency Stability vs. Voltage	2.1055 (d)	pg 20
Transient Frequency Behavior	90.214	pg 21 - 24

TYPE OF EXHIBIT: TEST EQUIPMENT LIST
FCC PART: 2.947 (d)
MANUFACTURER: RITRON, INC.
 505 West Carmel Drive
 Carmel, IN 46032
MODEL: DTX-145
TYPE OF UNIT: VHF-FM Two Way Radio Transceiver Module
FCC ID: AIERIT17-145
DATE: 9 July 2010

The measured data in this report were obtained using one or more of the following pieces of equipment. The particular equipment used in any one test is detailed in the procedure for that test.

<u>ITEM</u>	<u>MANUFACTURER</u>	<u>MODEL NO.</u>	<u>SERIAL NO.</u>	<u>Last Cal</u>	<u>EXP Cal</u>
Comms Test Set	Hewlett-Packard	HP8920A	3352A03633	9-2-10	8-6-11
Comms Test Set	Aeroflex	IFR2944B	294507/590	8-6-09	8-6-11
Signal generator	Hewlett-Packard	HP8657B	3315V04378	9-2-10	8-6-11
Spectrum Analyzer	Hewlett-Packard	8560E	3720A02980	9-2-10	8-6-11

Support equipment:

<u>ITEM</u>	<u>MANUFACTURER</u>	<u>MODEL NO.</u>	<u>SERIAL NO.</u>
Power Supply	HQ	PS3010U	
Function Generator	BK Precision	4010	275-00280
Digital Oscilloscope	Philips	PM-3335	DM630034
Digital Multimeter	Hewlett-Packard	3466A	
Log Periodic Antenna	Electro-Metrics	LPA-25	8-102
Temperature Chamber	Delta Design	3900CL	0-52-R
Thermocouple	Triplet	320-G/O	
272 MHz high pass filter	Ritron		

TYPE OF EXHIBIT: DESCRIPTION OF MEASUREMENT FACILITY

FCC PART: 2.947 (d)

MANUFACTURER: RITRON, INC.
505 West Carmel Drive
Carmel, IN 46032

MODEL: DTX-145

TYPE OF UNIT: VHF-FM Two Way Radio Transceiver Module

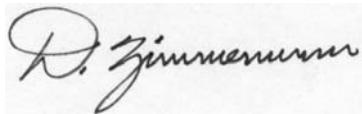
FCC ID: AIERIT17-145

DATE: 11 May 2010

The Field Strength measurements filed with this application were made on a site certified by RITRON, Inc. Data pertaining to this site are on file with the FCC and Industry Canada and are current.

This site is used on a continuing basis exclusively by RITRON, Inc. and is utilized only for RF Field Strength measurements of equipment designed and manufactured by RITRON, Inc. It is not used for measurements by, or for, any other party on a contract basis or otherwise.

All other measurements were taken at RITRON's Engineering Laboratory in Carmel, IN. Attached is a photograph of the test site.



Dennis Zimmerman
Project Engineer
RITRON, Inc.



RITRON Test Site

TYPE OF EXHIBIT: RADIO FREQUENCY POWER OUTPUT

FCC PART: 2.1046(a)

MANUFACTURER: RITRON, INC.
505 West Carmel Drive
Carmel, IN 46032

MODEL: DTX-145

TYPE OF UNIT: VHF-FM Two Way Radio Transceiver Module

FCC ID: AIERIT17-145

DATE: 19 May 2010

PROCEDURE:

1. The DTX-145 was aligned for transmitter operation at three power levels per the tune-up procedure outlined in the Maintenance manual for frequencies at the lower, middle and upper band edges.
2. Measurements were taken at 1, 5 and 7 watts
3. Power was supplied to the DTX-145 by a PS3010U power supply set at 12 volts for 1 Watt and 5 Watt measurements and at 14 volts for 7 Watt measurements. The DTX-145 was connected to a HP8920A Test Set used to measure the RF carrier power. The input to the Test Set provides a resistive 50-ohm termination at the frequencies and power levels used for this test.
4. The voltage across an internal shunt in series with the power supply lead of the RF Power FET was used with an HP Digital Multimeter to measure current (Id). An HP digital multi-meter was used to measure the RF Power FET output stage drain voltage (Vd) and driver stage control voltage (Vcon). Overall total current consumption is also noted.

TYPE OF EXHIBIT: RADIO FREQUENCY POWER OUTPUT

FCC PART: 2.1046(a)

MANUFACTURER: RITRON, INC.
505 West Carmel Drive
Carmel, IN 46032

MODEL: DTX-145

TYPE OF UNIT: VHF-FM Two Way Radio Transceiver Module

FCC ID: AIERIT17-145

DATE: 19 May 2010

RESULTS:

Supply (VDC)	Frequency (MHz)	Power (Watts)	Vcon (Volts)	Vd (Volts)	Id (Amps)	Itotal (Amps)
12V	155	1	3	11.6	0.28	0.42
12V	174	1	3.98	11.6	0.29	0.41
12V	155	5	11.5	11.66	0.8	1.00
12V	174	5	9.3	11.54	0.8	0.96
14V	155	7	13.5	13.38	0.97	1.26
14V	174	7	10.8	13.38	0.97	1.17

TYPE OF TEST: TRANSMITTER AUDIO OVERALL RESPONSE

FCC PART: 2.1047 (a)

MANUFACTURER: RITRON, INC.
505 West Carmel Drive
Carmel, IN 46032

MODEL: DTX-145

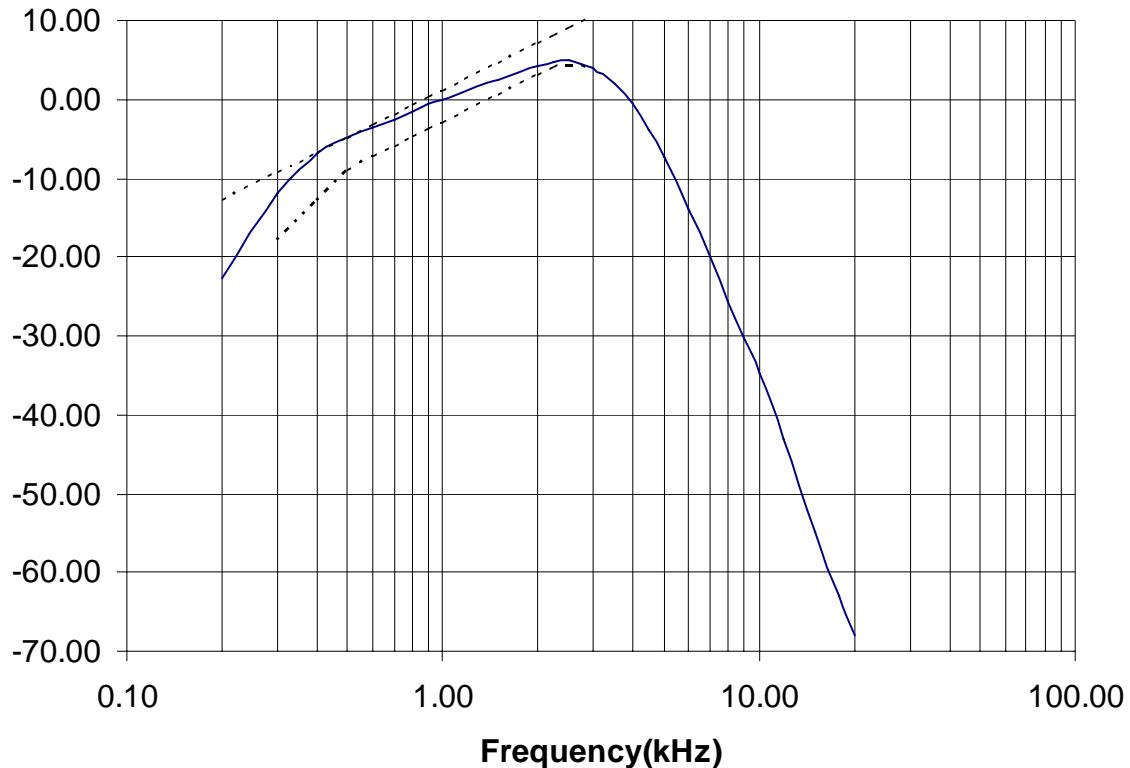
TYPE OF UNIT: VHF-FM Two Way Radio Transceiver Module

FCC ID: AIERIT17-145

DATE: 19 May 2010

PROCEDURE: A constant input level of 140 mV rms was applied to the microphone input of the unit. The microphone gain was adjusted to keep the highest amplitude signal from limiting. The demodulated output of the HP8920A was sent to the input of the HP8560E. The frequency response was plotted relative to the 1 kHz reference. TIA-603-C frequency response limits are shown.

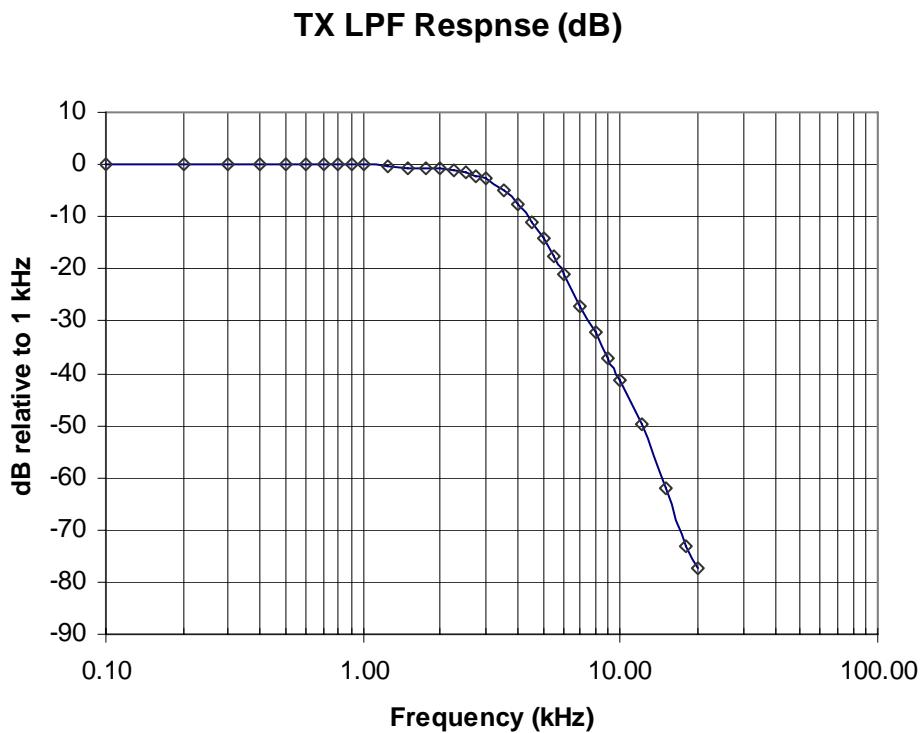
RESULTS:



TYPE OF TEST: TRANSMITTER LOW PASS FILTER
FCC PART: 2.1047 (a)
MANUFACTURER: RITRON, INC.
 505 West Carmel Drive
 Carmel, IN 46032
MODEL: DTX-145
TYPE OF UNIT: VHF-FM Two Way Radio Transceiver Module
FCC ID: AIERIT17-145
DATE: 19 May 2010

PROCEDURE: An audio tone ranging from 100 Hz to 20 kHz was inserted at the AUX_IN input of the DTX-145. The audio test tone amplitude was fixed at 250 mV rms keeping the filter in a linear (not limiting) mode. The HP8920A demodulated output was read by an HP8560E spectrum analyzer.

RESULTS:



TYPE OF TEST: MODULATION LIMITING

FCC PART: 2.1047 (b)

MANUFACTURER: RITRON, INC.
505 West Carmel Drive
Carmel, IN 46032

MODEL: DTX-145

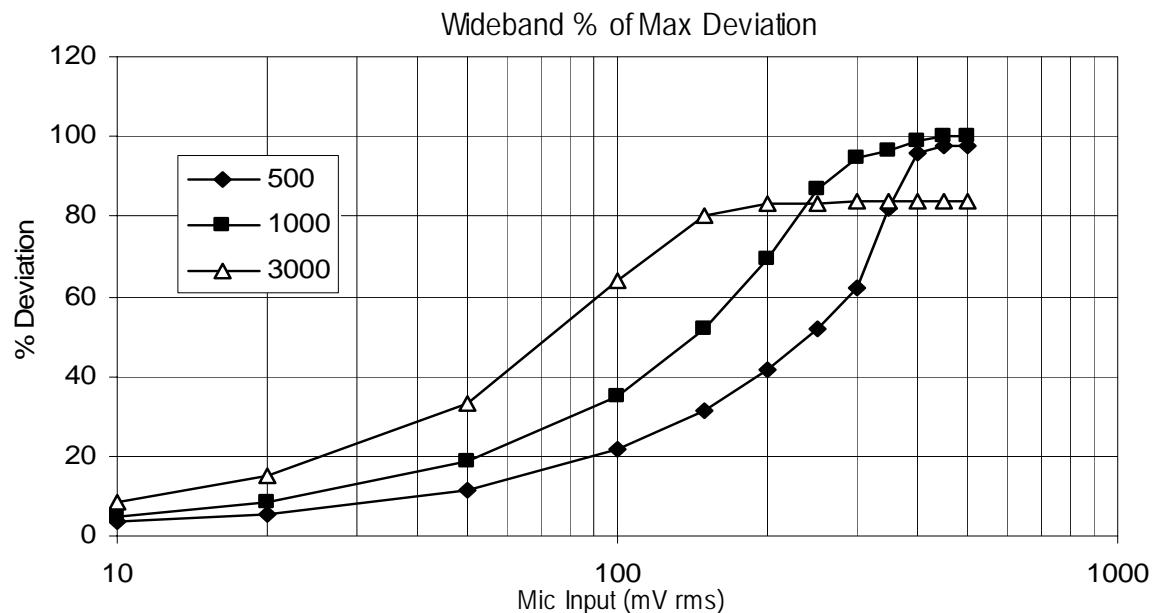
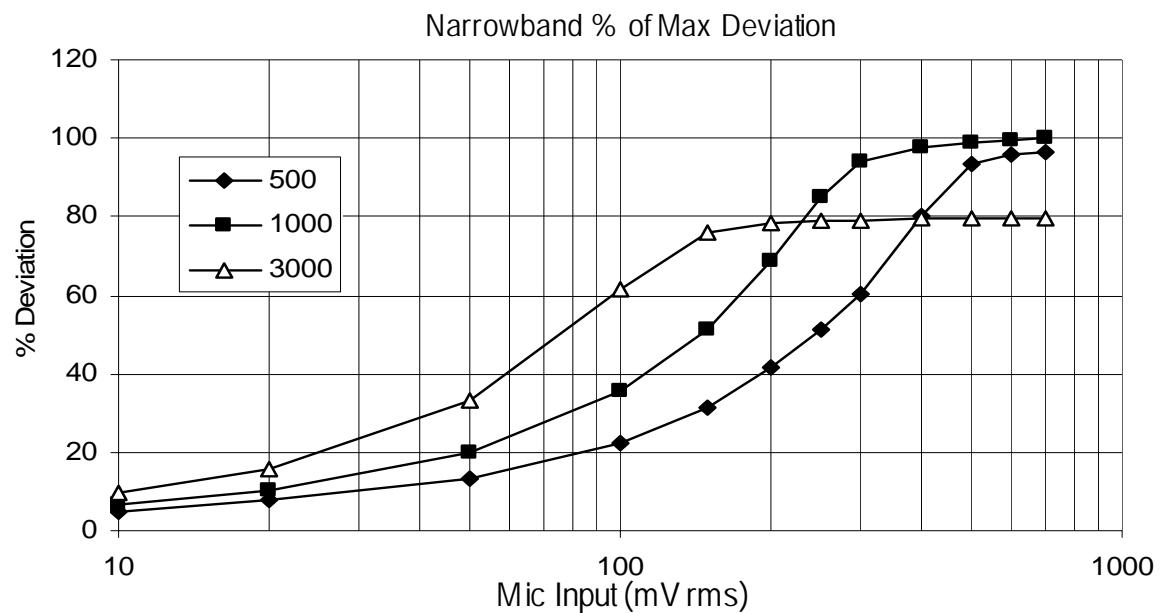
TYPE OF UNIT: VHF-FM Two Way Radio Transceiver Module

FCC ID: AIERIT17-145

DATE: 19 May 2010

PROCEDURE: The output of the HP8920A audio generator was applied to the microphone input of the DTX-145. The microphone gain was set to about 13% of maximum to allow low noise measurements. The output of the generator was adjusted from 10 mV to 700 mV RMS at frequencies from 500 to 3000 Hz. The receiver had a <20 Hz to 15 kHz filter. The deviations were normalized to the maximum deviation, which occurred at 1000 Hz. Displayed are narrowband (12.5 kHz) and wideband (25 kHz) plots of the maximum of the plus and minus peak deviations as outlined in TIA-603-C.

TYPE OF TEST: MODULATION LIMITING
FCC PART: 2.1047 (b)
MANUFACTURER: RITRON, INC.
 505 West Carmel Drive
 Carmel, IN 46032
MODEL: DTX-145
TYPE OF UNIT: VHF-FM Two Way Radio Transceiver Module
FCC ID: AIERIT17-145
DATE: 20 May 2010



TYPE OF TEST:	EMISSIONS DESIGNATOR
MANUFACTURER:	RITRON, INC. 505 West Carmel Drive Carmel, IN 46032
MODEL:	DTX-145
TYPE OF UNIT:	VHF-FM Two Way Radio Transceiver Module
FCC ID:	AIERIT17-145
DATE:	20 May 2010

CALCULATIONS:

The necessary bandwidth as determined by Carson's rule for a wideband voice channel is:

Maximum modulation frequency (M) in kHz	= 2.5
Maximum deviation (D) in kHz	= 5
Constant K	= 1
Necessary bandwidth for wideband in kHz	= $(2 \times M) + (2 \times D \times K) = 15$

Wideband emissions designator applied for is 15K0F3E.

The necessary bandwidth for the narrowband voice channel is:

Maximum modulation frequency (M) in kHz	= 2.5
Maximum deviation (D) in kHz	= 2.5
Constant K	= 1
Necessary bandwidth for narrowband in kHz	= $(2 \times M) + (2 \times D \times K) = 10$

Narrowband emissions designator applied for is 10K0F3E.

The necessary bandwidth for the narrowband data channel is:

Maximum modulation frequency (M) in kHz	= 2.4
Maximum deviation (D) in kHz	= 2.5
Constant K	= 1
Necessary bandwidth for narrowband in kHz	= $(2 \times M) + (2 \times D \times K) = 9.8$

Narrowband emissions designator applied for is 9K8F1D.

TYPE OF TEST: OCCUPIED BANDWIDTH

FCC PART: 2.1049 (c)(1) per 90.210 (b)(d)

MANUFACTURER: RITRON, INC.
505 West Carmel Drive
Carmel, IN 46032

MODEL: DTX-145

TYPE OF UNIT: VHF-FM Two Way Radio Transceiver Module

FCC ID: AIERIT17-145

DATE: 9 July 2010

PROCEDURE:

1. Testing was done in accordance with TIA-603-C. The DTX-145 was programmed for transmitter operation on 161.000 MHz. The transmitter was adjusted for a deviation of +/- 5 kHz at 1000 Hz for wideband channels or +/- 2.4 kHz at 1000 Hz for narrowband channels. The first plot shows voice occupied bandwidth for 12.5 kHz bandwidth operation with a 2500 Hz audio tone. The second plot shows voice occupied bandwidth for 25 kHz wide band operation with a 2500 Hz tone. The third plot shows the narrowband data occupied bandwidth with a square wave at 2400 bits/sec. This is the worse case spectrum for a 2 level 4800 bits/sec or a 4 level 9600 bits/sec channel.
2. The RF output of the DTX-145 was measured with an HP8920A communications test set wattmeter at 7.0 watts. Power was set at +14 VDC.
3. The unit's antenna port was connected to the HP8560E spectrum analyzer via a 20 dB power attenuator.
4. The output of the HP8920A audio function generator was applied to the microphone input of the DTX-145 for voice and the AUX_IN port for data. The frequency of the audio signal generator was set to 2500 Hz for voice or 2400 Hz for data and the output adjusted to a level 16 dB greater than that necessary to produce 50% of the rated system deviation at the frequency of maximum response.
5. The spectrum analyzer was centered on 161.000 MHz and the sidebands were capture in max hold mode on the spectrum analyzer. The appropriate narrow or wide band emission mask was also superimposed.

TYPE OF TEST: 12.5 kHz VOICE OCCUPIED BANDWIDTH

FCC PART: 2.1049 (c)(1) per 90.210 (b)(d)

MANUFACTURER: RITRON, INC.
505 West Carmel Drive
Carmel, IN 46032

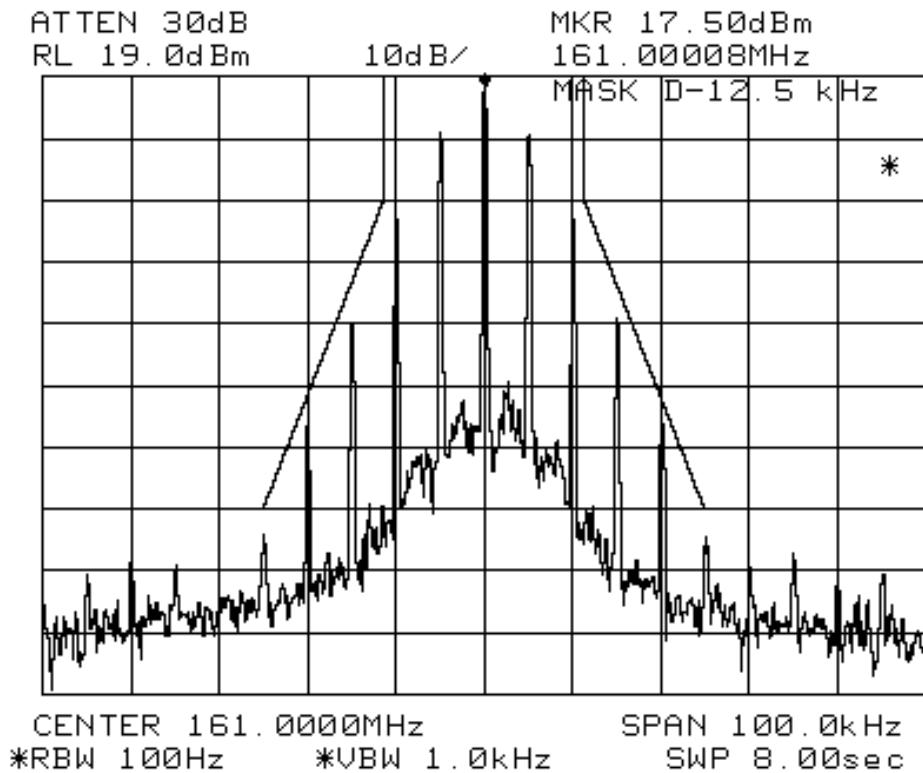
MODEL: DTX-145

TYPE OF UNIT: VHF-FM Two Way Radio Transceiver Module

FCC ID: AIERIT17-145

DATE: 9 July 2010

DATA: 12.5 kHz voice channel with 2500 Hz tone.



TYPE OF TEST: 25 kHz VOICE OCCUPIED BANDWIDTH

FCC PART: 2.1049 (c)(1) per 90.210 (b)(d)

MANUFACTURER: RITRON, INC.
505 West Carmel Drive
Carmel, IN 46032

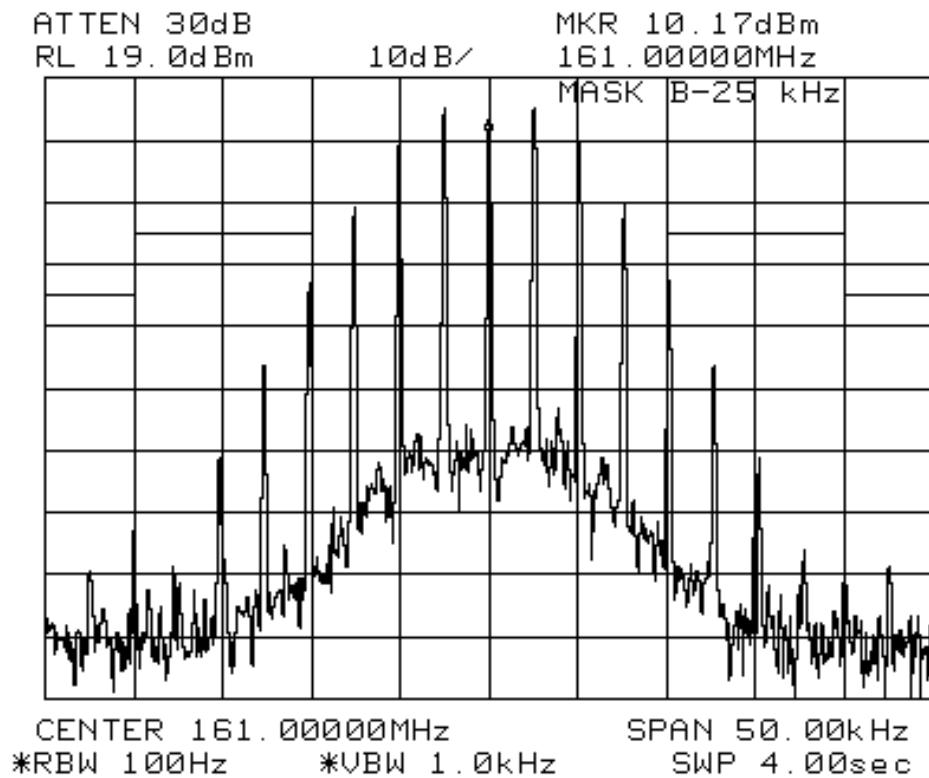
MODEL: DTX-145

TYPE OF UNIT: VHF-FM Two Way Radio Transceiver Module

FCC ID: AIERIT17-145

DATE: 9 July 2010

DATA: 25 kHz voice with 2500 Hz tone.



TYPE OF TEST: 12.5 kHz DATA OCCUPIED BANDWIDTH

FCC PART: 2.1049 (c)(1) per 90.210 (b)(d)

MANUFACTURER: RITRON, INC.
505 West Carmel Drive
Carmel, IN 46032

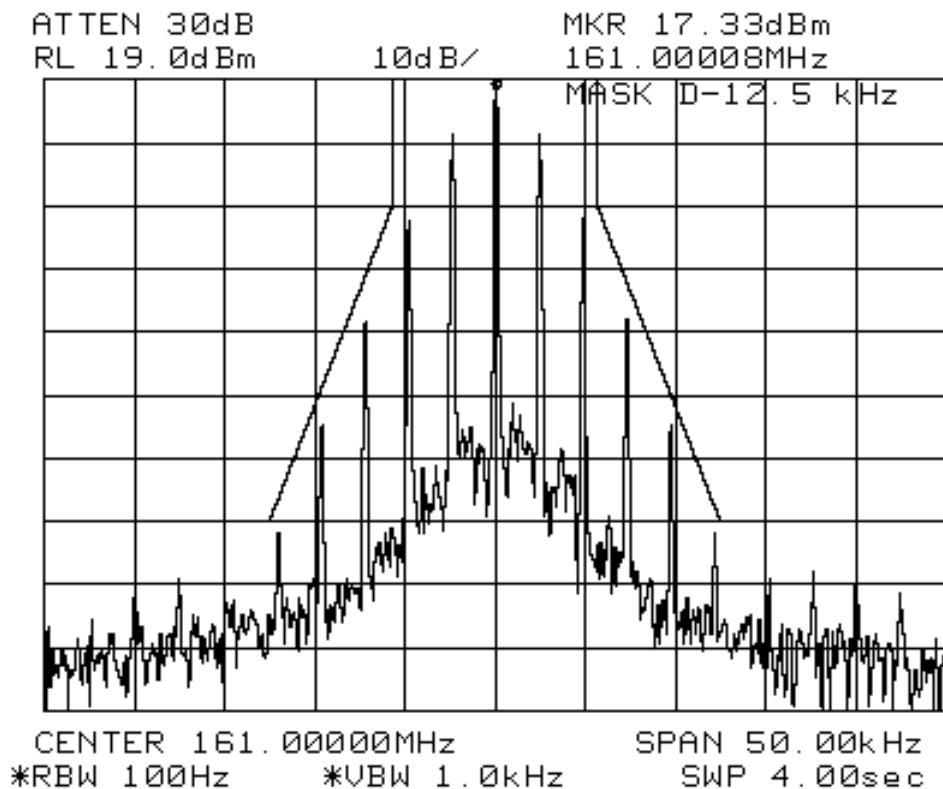
MODEL: DTX-145

TYPE OF UNIT: VHF-FM Two Way Radio Transceiver Module

FCC ID: AIERIT17-145

DATE: 9 July 2010

12.5 kHz data:



TYPE OF TEST: SPURIOUS EMISSIONS AT ANTENNA TERMINALS
TRANSMITTER

FCC PART: 2.1051

MANUFACTURER: RITRON, INC.
505 West Carmel Drive
Carmel, IN 46032

MODEL: DTX-145

TYPE OF UNIT: VHF-FM Two Way Radio Transceiver Module

FCC ID: AIERIT17-145

DATE: 19 May 2010

PROCEDURE:

The DTX-145 was programmed for transmitter operation on low, middle and high frequencies. The supply voltage was set to 14 VDC. The transmitter was modulated by a 2500 Hz tone at an input level 16 dB greater than that necessary to produce 50 percent modulation as specified in FCC Part 2.1049 (c)(1). The DTX-145 antenna terminal was connected to the input of a 20 dB power attenuator. After the attenuator and before the HP8560E Spectrum Analyzer a 272 MHz high pass filter was inserted. The measured insertion loss of the external attenuator and HPF is listed on the data sheet. The spectrum was searched from 8 MHz to the 10th harmonic of the operating frequency. All unreported emissions are more than 20 dB below the FCC limit.

RESULTS:

Power Output: 7.00 Watts 14 VDC

Multiple of Carrier	Emmission Frequency (MHz)	Analyzer Reading (dBm)	Atten/HPF Correctio n Factor(dB)	Spurious Power (dBm)	FCC Limit (dBm)	dB below FCC Limit
	155.000	None				
3	174.000 522.0000	-57	21	-36	-20	16

TYPE OF TEST: FIELD STRENGTH OF SPURIOUS RADIATION

FCC PART: 2.1053

MANUFACTURER: RITRON, INC.
505 West Carmel Drive
Carmel, IN 46032

MODEL: DTX-145

TYPE OF UNIT: VHF-FM Two Way Radio Transceiver Module

FCC ID: AIERIT17-145

DATE: 25 May 2010

PROCEDURE:

Field strength of spurious radiation of the DTX-145 was taken on the RITRON three meter test range using the substitution method. The following procedure was used. It follows the TIA-603-C standard except that the RAM-1545 antenna was used rather than a load.

1. The DTX-145 was programmed to transmit at 7.0 watts on 161 and 174 MHz powered by a 14 VDC power supply.
2. The DTX-145 was then terminated at the antenna port with a RAM-1545 whip on a metal ground plane.
3. All field strength measurements were made with the Hewlett-Packard Model 8560E Spectrum Analyzer connected to the Electro-Metrics LPA-25 log periodic or EMCO horn receiving antenna.
4. A tuned Electro-Metrics dipole was substituted at the radio side of the range driven by a known power level from the HP8657B to produce a known ERP at each harmonic. The receiving antenna was oriented both vertically and horizontally and reference measurements were taken at each harmonic. Cable loss from generator to the dipole was taken into account.
5. For each emission, the height and polarization of the field strength measuring antenna and orientation of the DTX-145 were varied to find maximum field strength.
6. The spectrum was searched up to the 10th harmonic of the transmit frequency. All non-harmonics were less than 20 dB below the FCC limits specified in Part 90.210(d)(3). All harmonics with greater than 20 dB margin were not reported.

TYPE OF TEST: FIELD STRENGTH OF SPURIOUS RADIATION

FCC PART: 2.1053

MANUFACTURER: RITRON, INC.
505 West Carmel Drive
Carmel, IN 46032

MODEL: DTX-145

TYPE OF UNIT: VHF-FM Two Way Radio Transceiver Module

FCC ID: AIERIT17-145

DATE: 25 May 2010

RESULTS: Spurious levels

DTX-145 horizontal @ 161 MHz

Cable loss (dB)	Sub horz reading(dBm))	Max Horz (dBm)	Max Spur ERP(dBm))	Max Spur ERP(dBc))	FCC limit(dBm)	FCC margin(dB))
161 0	-22.8	11.8	34.7			
483 -2.0	-29.7	-67.00	-39.3	-74	-20	19

DTX-145 horizontal @ 174 MHz

Cable loss (dB)	Sub horz reading(dBm))	Max Horz (dBm)	Max Spur ERP(dBm))	Max Spur ERP(dBc))	FCC limit(dBm)	FCC margin(dB))
174 0	-26.0	6.8	32.8			
870 -2.7	-37.7	-74.83	-39.9	-73	-20	20

Note: spurious levels more than 20 dB below the FCC specifications were not recorded.

TYPE OF TEST: FREQUENCY STABILITY VS. TEMPERATURE
FCC PART: 2.1055 (a)(1)
MANUFACTURER: RITRON, INC.
 505 West Carmel Drive
 Carmel, IN 46032
MODEL: DTX-145
TYPE OF UNIT: VHF-FM Two Way Radio Transceiver Module
FCC ID: AIERIT17-145
DATE: 25 May 2010

PROCEDURE:

1. The DTX-145 was programmed for operation at 7.0 watts on 161 MHz.
2. The unit was placed inside an Associated Testing Labs temperature chamber and supplied with 14 VDC. The DTX-145 antenna terminal was connected to the input of an HP8920A RF communications test set used to measure frequency of the carrier.
1. The temperature was lowered to -30 degrees C as monitored by a Triplett model 320-G/P thermocouple placed inside the chamber.
2. After soaking for 10 minutes the transmitter frequency was read.
3. The temperature was increased in 10 degree decrements and allowed to soak 5 minutes before the next frequency measurement was made. The reference of 20°C was used to normalize the plot.
4. The frequency remained within the 2.5 ppm specified.

Temperature (°C)	upper limit (ppm)	lower limit (ppm)	Frequency (MHz)	Deviation (Hz)	Deviation (ppm)
60	2.5	-2.5	161.000010	-56	-0.35
50	2.5	-2.5	161.000080	14	0.09
40	2.5	-2.5	161.000066	0	0.00
30	2.5	-2.5	161.000048	-18	-0.11
20	2.5	-2.5	161.000066	0	0.00
10	2.5	-2.5	160.999975	-91	-0.57
0	2.5	-2.5	160.999984	-82	-0.51
-10	2.5	-2.5	161.000046	-20	-0.12
-20	2.5	-2.5	160.999922	-144	-0.89
-30	2.5	-2.5	160.999853	-213	-1.32

TYPE OF TEST: FREQUENCY STABILITY VS. VOLTAGE
FCC PART: 2.1055 (d)(1)
MANUFACTURER: RITRON, INC.
 505 West Carmel Drive
 Carmel, IN 46032
MODEL: DTX-145
TYPE OF UNIT: VHF-FM Two Way Radio Transceiver Module
FCC ID: AIERIT17-145
DATE: 11 May 2009

PROCEDURE:

1. The DTX-145 was programmed for operation at 7 watts at 161.000 MHz.
2. Frequency was checked from 85% of minimum to 115% of maximum specified operating voltage. Minimum of $9 \times 0.85 = 7.65$ v, Maximum of $17 \times 1.15 = 19.55$ v.
3. The DTX-145 antenna terminal was connected to the input of an HP8920A communications test set, used to measure frequency of the carrier.
4. Frequency measurements were made at $+22^{\circ}\text{C}$ with supply varied in 1 volt steps beginning at 7 volts and ending at 20 volts.
4. The following plot shows the frequency error within the ± 2.5 PPM limits over the units specified 9 to 17 volt operating range. The reference voltage was 12 volts.

Supply Voltage	Transmit Frequency	Freq error (Hz)	PPM error from nominal
7	161.000032	-8.0	-0.05
8	161.000037	-3.0	-0.02
9	161.000033	-7.0	-0.04
10	161.000032	-8.0	-0.05
11	161.000036	-4.0	-0.02
12	161.000040	0.0	0.00
13	161.000042	2.0	0.01
14	161.000044	4.0	0.02
15	161.000044	4.0	0.02
16	161.000050	10.0	0.06
17	161.000044	4.0	0.02
18	161.000057	17.0	0.11
19	161.000062	22.0	0.14
20	161.000069	29.0	0.18

TYPE OF TEST: TRANSIENT FREQUENCY BEHAVIOR

FCC PART: 90.214

MANUFACTURER: RITRON, INC.
505 West Carmel Drive
Carmel, IN 46032

MODEL: DTX-145

TYPE OF UNIT: VHF-FM Two Way Radio Transceiver Module

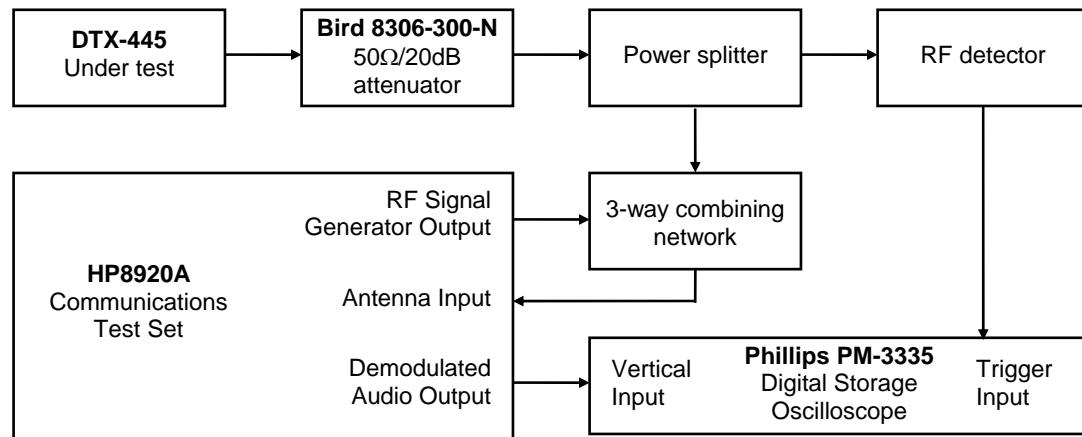
FCC ID: AIERIT17-145

DATE: 20 May 2010

PROCEDURE:

The DTX-145 was programmed for 7 watt transmitter operation on 161 MHz using 14 VDC.

1. The test equipment was connected per the following diagram and tested in accordance with TIA-603-C:

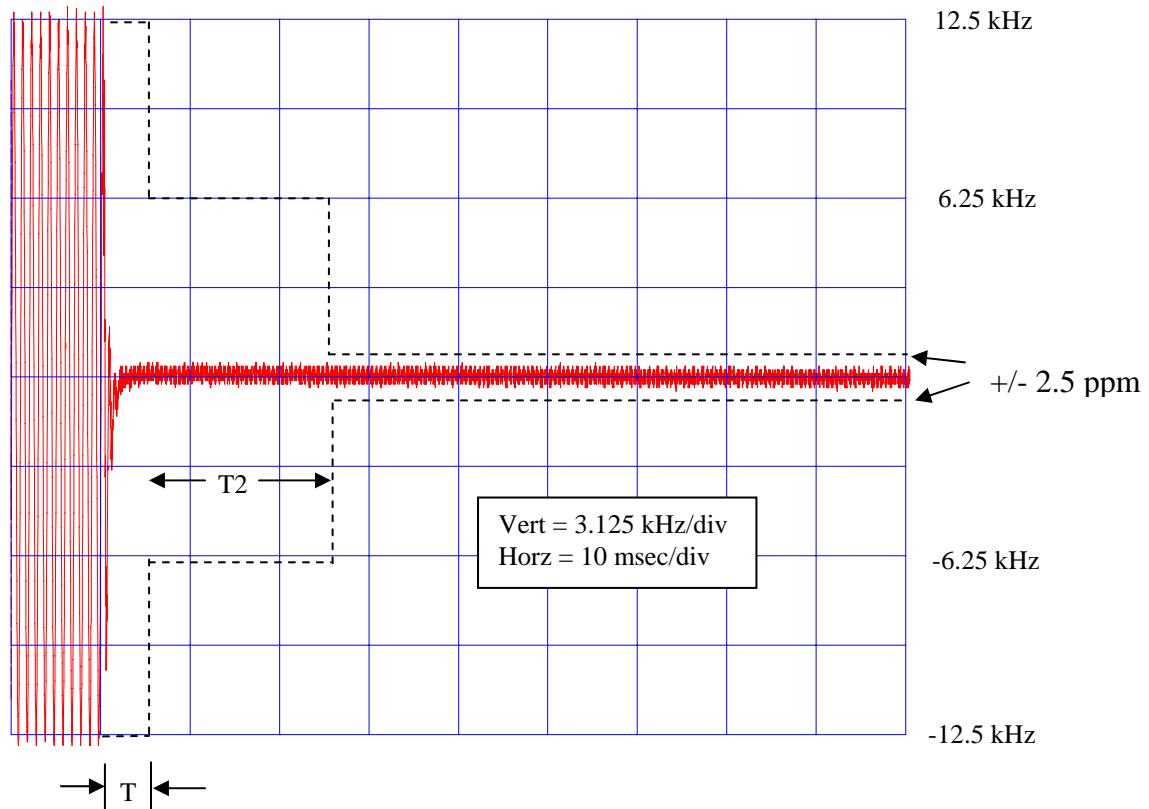


2. The HP8920A receiver was set to measure FM deviation with the audio bandwidth set at ≤ 20 Hz to 15 kHz and the RF frequency set to 161.000 MHz.
3. The DTX-145 transmitter under test was turned on and the HP8920A Spectrum Analyzer was used to measure the RF power level through the test network.
4. The DTX-145 transmitter was turned off.
5. The HP8920A RF signal generator was set to 161.000 MHz at an RF level 30 dB below that measured in step 3, modulated with a 1 kHz tone at ± 12.5 kHz deviation.
6. The Phillips PM-3335 digital oscilloscope horizontal sweep rate was set to 10 mS per division. The vertical amplitude control was adjusted to display the 1000 Hz demodulated audio from the signal generator at ± 4 divisions (3.125 kHz/div), vertically centered on the screen.

7. The Phillips PM-3335 digital oscilloscope was set to trigger at 1 division from the left side of the display when the RF detector senses RF power from the DTX-145 transmitter.
8. The DTX-145 transmitter is turned on and the resulting waveform on the oscilloscope display was stored and plotted. The FCC limits per Part 90.214 were added to the plot in the same manner illustrated in EIA-603-C Part 3.2.19. The resulting plot is labeled "Switch ON" and shows compliance with FCC Part 90.214.
9. The Phillips PM-3335 digital oscilloscope was set to trigger at 1 division from the right side of the display when the RF detector senses loss of RF power from the DTX-145 transmitter.
10. The DTX-145 transmitter is turned off and the resulting waveform on the oscilloscope display was stored and plotted. The FCC limits per Part 90.214 were added to the plot in the same manner illustrated in EIA-603-C Part 3.2.19. The resulting plot is labeled "Switch OFF" and shows compliance with FCC Part 90.214.

TYPE OF TEST: TRANSIENT FREQUENCY BEHAVIOR
FCC PART: 90.214
MANUFACTURER: RITRON, INC.
 505 West Carmel Drive
 Carmel, IN 46032
MODEL: DTX-145
TYPE OF UNIT: VHF-FM Two Way Radio Transceiver Module
FCC ID: AIERIT17-145
DATE: 20 May 2010

SWITCH ON CONDITION: T = 5 msec, T2 = 20 msec



TYPE OF TEST: TRANSIENT FREQUENCY BEHAVIOR
FCC PART: 90.214
MANUFACTURER: RITRON, INC.
 505 West Carmel Drive
 Carmel, IN 46032
MODEL: DTX-145
TYPE OF UNIT: VHF-FM Two Way Radio Transceiver Module
FCC ID: AIERIT17-145
DATE: 20 May 2010

SWITCH OFF CONDITION: T = 5msec

